Renal and Ureteral Trauma

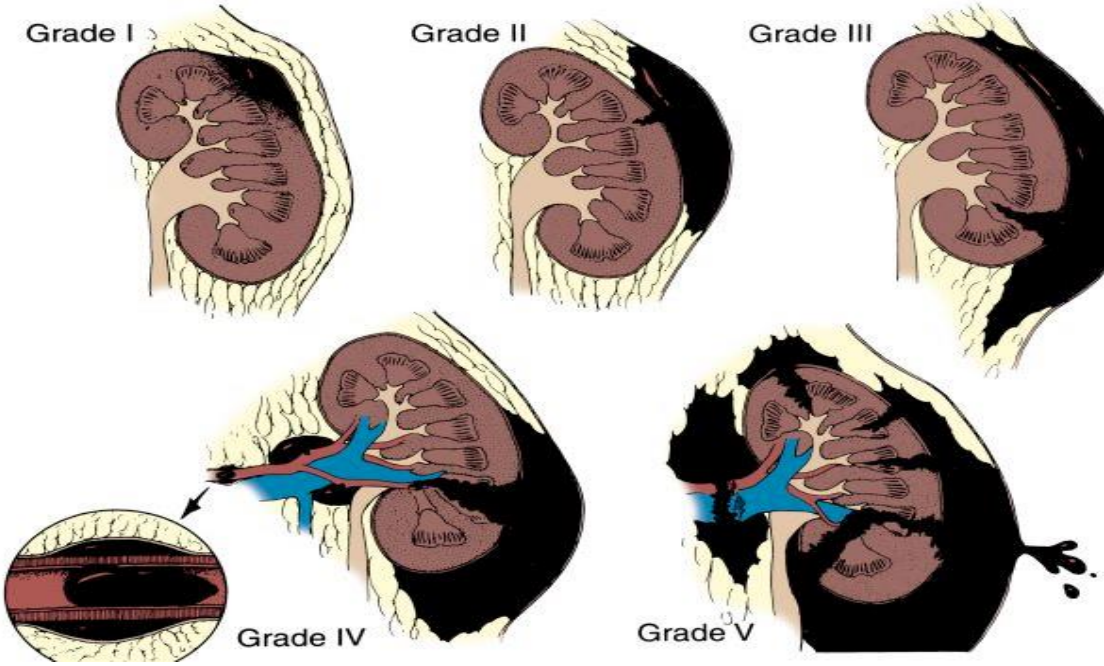
RENAL INJURIES

- **Incidence**
  - 10% of abdominal injuries
  - renal trauma is the most common (2/3 of all GU trauma)
  - 90 % of renal injuries are grade 1
  - 90% of blunt renal injuries can be managed non-operatively
  - 50% of stab wounds and ~25% of GSW can be managed non-operatively
  - 90 % of renal injuries have major associated organ injury

- **Causes**
  - blunt injuries , rapid deceleration or high-velocity-impact trauma
  - penetrating injuries , GSW or stab wound to upper abdomen, flank, or lower chest
  - Iatrogenic

- **classification of renal injuries**
  - grade 1
    - renal contusion (hematuria + N imaging)
    - OR subcapsular hematoma (nonexpanding)
  - grade 2
    - } nonexpanding perirenal hematoma (confined to retroperitoneum)
    - OR laceration (<1cm)
  - grade 3
    - laceration >1cm WITHOUT violation of collecting system or urinary extravasation
  - grade 4
    - laceration into collecting system
    - OR main renal artery or vein injury w/ contained hemorrhage (including segmentals)

- grade 5
    - shattered kidney
    - OR avulsion of renal hilum (devascularized kidney)



- **Diagnosis and management**

Haemodynamic stability should be assessed upon admission:

-History should regard to

- the time and setting of the incident.
- Past renal surgery
- pre-existing renal abnormalities (ureteropelvic junction obstruction, large cysts, lithiasis)

examination of the

- thorax,
- abdomen,
- flanks and back for penetrating wounds.

Findings on physical examination such

- as haematuria,
    - **degree of hematuria does not correlate with severity of injury**
    - can present with microscopic or gross
        - use 1st aliquot of catheterized specimen or initial voided specimen
        - >5RBCs/HPF is considered significant
- flank pain,
- flank abrasions
- bruising ecchymoses,
- fractured ribs,
- abdominal tenderness,
- distension or mass,

- **Investigation**

1) **Laboratory**
    - Urine analysis (visually or by dipstick analysis).
    - serial haematocrit measurement
    - Creatinine to identify patients with impaired renal function prior to injury
2) **Imaging**
    - ✓ **Indication of imaging**
        - blunt trauma
            - gross hematuria
            - microscopic hematuria + shock (sBP <90)
            - no hematuria but highly suspicious mechanism of injury (eg rapid deceleration)
        - penetrating trauma
            - any degree of hematuria
        - kids
            - w/ any degree of hematuria
            - if <50 RBC/hpf, may not be needed?? ??

- ✓ **imaging studies**

1) CT with contrast and delayed images (~10mins) the gold standard
    - limitation is inability to define renal venous injury adequately
    - Finding suggestive of renal vascular injury
        - medial hematoma (vascular injury or UPJ injury)
        - lack of contrast enhancement of parenchyma (arterial injury)
        - kidney displaced laterally

2) IVP (intra-op, single-shot film)
    - iv push of 2 mL/kg of contrast material followed by film taken at 10min post-injection
    - ✓ indications
        - unexpected retroperitoneal hematoma
        - incomplete staging (unstable for imaging) + suspicion for renal injury
            - exploration indicated if study is abN or near normal
3) arteriography
    - limited role initially
    - indications
        - to define arterial injury suspected on CT
        - to localize arterial bleeding that can be controlled by embolization
        - to assess and treat delayed AVF that develops
4) **MRI and radiographic scintigraphy**
    - In the absence of or contraindication for CT, IVP
5) Ultrasonography
    - alone should not be used
    - it used in primary evaluation of polytrauma patients and for the follow-up of recuperating patients

- **Management**
  - **non-operative management**
    - ABC’s
    - admission and close monitoring of VS’s
    - bedrest until gross hematuria resolves; reinstate bedrest if gross hematuria returns w/ambulation
    - Abx if urinary extravasation
    - serial HgB and prn imaging
    - no strenuous activity for 6 weeks
    - ureteric stent or perc drain if continued urinary extravasation >48hrs
    - embolization for persistent bleeding or delayed bleeding } take to OR if not successful
    - Repeat imaging can be safely omitted for patients with grade 1-4 injuries as long as they remain clinically well
    - Computed tomography scans should always be performed on
      - patients with fever,
      - unexplained decreasing haematocrit
      - significant flank pain.
  - **indication of renal exploration**
    - ABSOLUTE
      - expanding perirenal hematoma
      - pulsatile perirenal hematoma
      - vascular injury in solitary kidney (or bilateral vascular injury)
      - unstable patient with evidence of persistent renal bleeding
      -
    - RELATIVE usually managed endoscopy
      - urinary extravasation
      - nonviable tissue with urinary extravasation
      - delayed Dx of arterial injury
      - segmental arterial injury
      - incomplete staging

- **approach to surgical exploration for renal trauma**
  - transabdominal approach best as it can assess other organs
  - isolate renal vessels , RP incision made over aorta just superior to IMA & medial to IMV early vessel isolation decreases Nx rate from ~50% to 20%
  - mobilize colon off Gerota's fascia
  - open Gerota's and dissect kidney free of surrounding hematoma

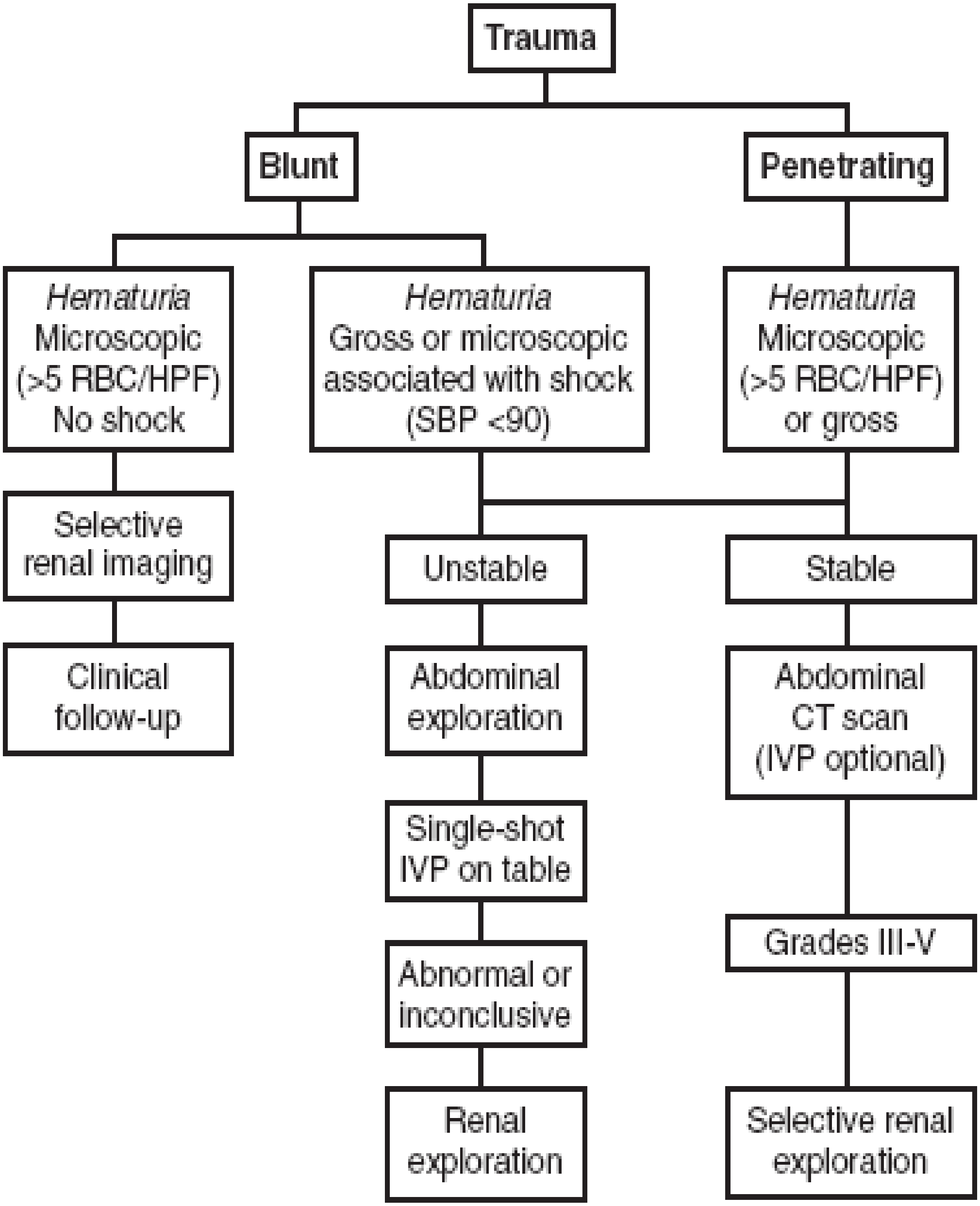
- **indications for Nx after renal trauma**
  - extensive renal injury threatening life
  - extensive renal injury with non-salvageable kidney

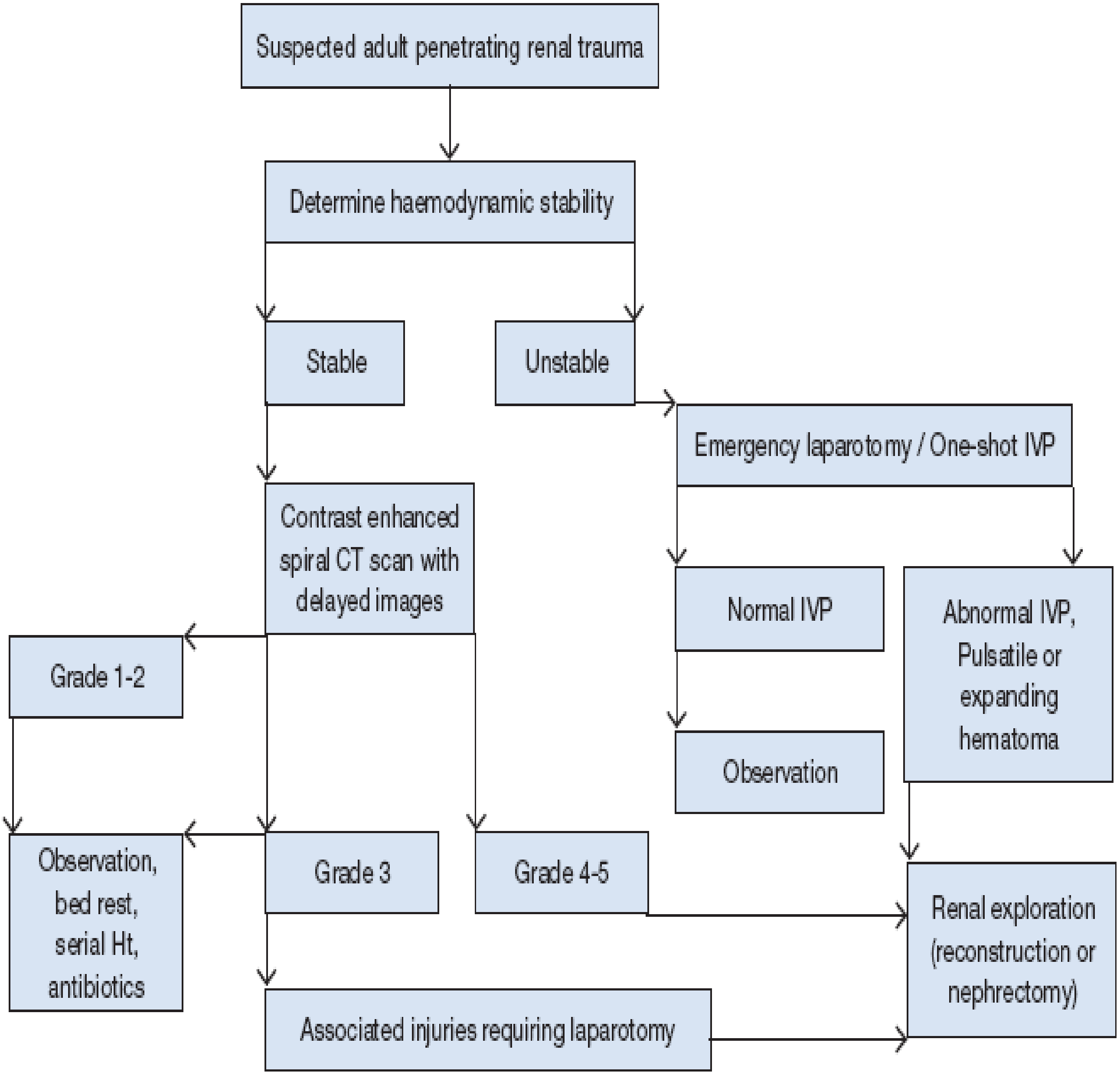
- **principles of renal reconstruction after trauma**
  - complete renal exposure
  - debridement of nonviable tissue
  - hemostasis with individual suture ligation of bleeding vessels
  - watertight closure of collecting system
  - coverage or approximation of parenchymal defect

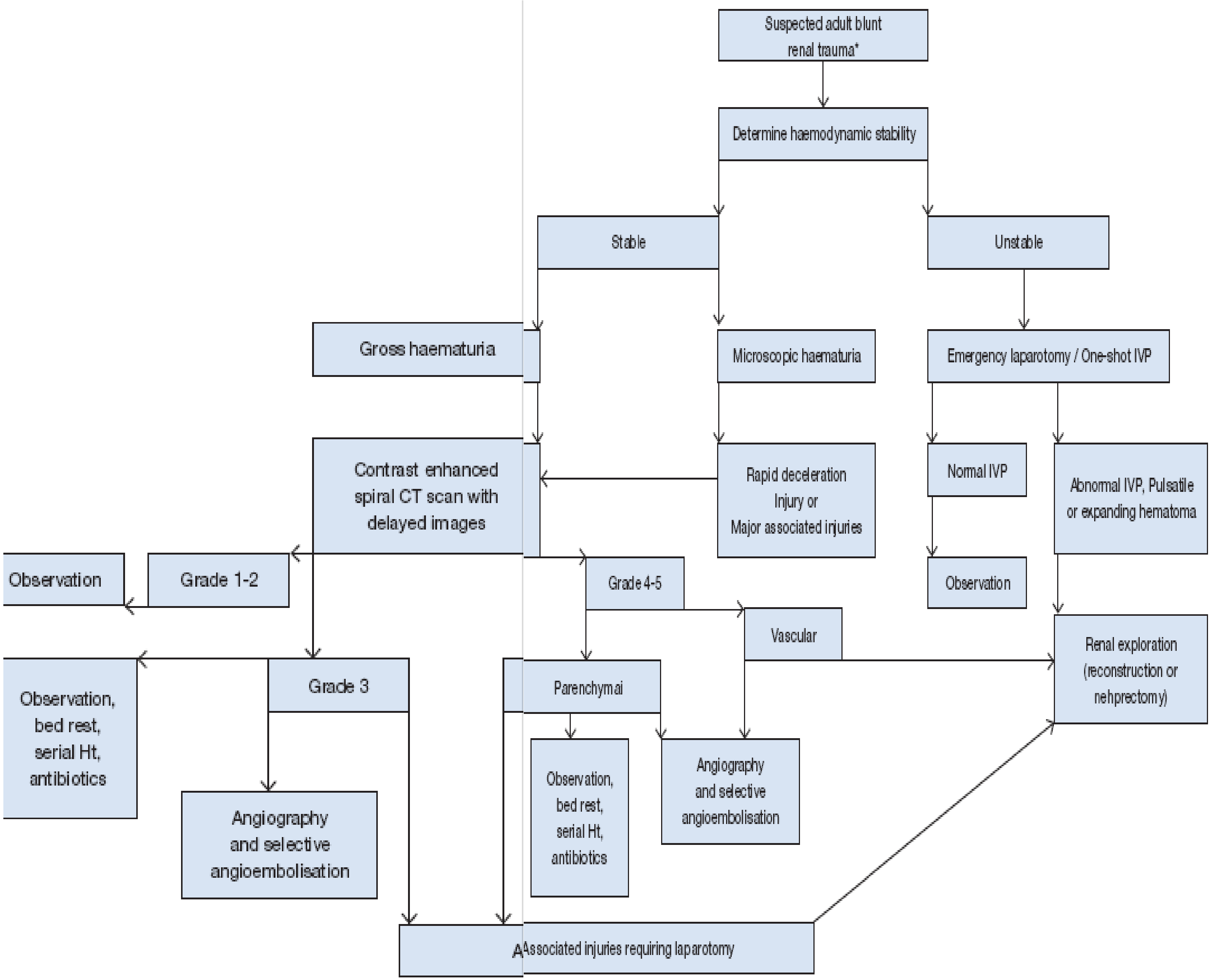
- **types of renal vascular injuries are common in trauma**
  - arterial
    - stretch from blunt deceleration causes intimal tear and formation of thrombus results in **renal artery thrombosis** and ischemia
      - **surgical revascularization seldom successful**
      - if arterial thrombosis Dx'd, need to operate **within 8hrs** to save kidney
      - "cortical rim" sign likely means delayed presentation of arterial injury
    - **main renal artery injuries usually require intervention** (Nx or vascular repair)
      - Nx preferred } no benefit to vascular repair, especially in blunt trauma
      - endovascular revascularization may have a role anticoagulation is often an issue

    - **segmental artery injuries are usually observed** unless associated with parenchymal laceration or >20% non-viable tissue
- venous
    - usually a venous tear requires closure with 5-0 prolene
    - **if small laceration or thrombosis, can try conservative non-operative mgt**
    - segmental venous injuries best managed by ligation (collateral venous drainage)

- **complications following renal trauma**
    - urinoma
    - perinephric infection
    - perinephric abscess (rare)
    - renal loss
    - delayed renal bleeding } usually occurs within 21 days
    - AVF (late)
    - HTN (late) } should resolve within 6 wks
        - **Cause** activation of RAAS by partial renal ischemia
            - renal vascular injury, leading to stenosis or occlusion of main/segmental renal artery
            - compression of renal parenchyma with extravasated blood or urine (Page kidney)
            - post-trauma AVF


Trauma
Blunt
Penetrating
Hematuria Microscopic (>5 RBC/HPF) No shock
Hematuria Gross or microscopic associated with shock (SBP <90)
Hematuria Microscopic (>5 RBC/HPF) or gross
Selective renal imaging
Clinical follow-up
Unstable
Stable
Abdominal exploration
Single-shot IVP on table
Abnormal or inconclusive
Renal exploration
Abdominal CT scan (IVP optional)
Grades III-V
Selective renal exploration


Suspected adult penetrating renal trauma
Determine haemodynamic stability
Stable
Unstable
Emergency laparotomy / One-shot IVP
Contrast enhanced spiral CT scan with delayed images
Normal IVP
Abnormal IVP, Pulsatile or expanding hematoma
Grade 1-2
Observation
Observation, bed rest, serial Ht, antibiotics
Grade 3
Grade 4-5
Renal exploration (reconstruction or nephrectomy)
Associated injuries requiring laparotomy


Suspected adult blunt renal trauma*
Determine haemodynamic stability
Stable
Unstable
Gross haematuria
Microscopic haematuria
Emergency laparotomy / One-shot IVP
Contrast enhanced spiral CT scan with delayed images
Rapid deceleration Injury or Major associated injuries
Normal IVP
Abnormal IVP, Pulsatile or expanding hematoma
Observation
Grade 1-2
Observation
Grade 4-5
Vascular
Renal exploration (reconstruction or nehprectomy)
Grade 3
Observation, bed rest, serial Ht, antibiotics
Parenchymai
Observation, bed rest, serial Ht, antibiotics
Angiography and selective angioembolisation
Angiography and selective angioembolisation
AAssociated injuries requiring laparotomy

URETERAL INJURIES

- **Incidence**
  - rare after external trauma unless extreme force } lumbar process #, thoracolumbar spinal dislocation
    - <4% of penetrating trauma
    - <1% of blunt trauma
  - when related to GSW, significant assoc'd injuries are often present (mortality rate of ~33%)
  - 10-30% have associated renal injuries
  - 5% have associated bladder injuries
- **classification of ureteral trauma**
  - grade 1 } contusion or hematoma without devascularization
  - grade 2 } <50% transection
  - grade 3) ≥50% transection
  - grade 4 } complete transection with <2cm devascularization
  - grade 5 } avulsion with >2cm devascularization

*** if bilateral, advance one grade up to grade 3 ***

- **imaging studies**
  - **CT with contrast and delayed films to trace ureters to bladder**
    - Finding suggestive PUJ avulsion
      - medial contrast extravasation
      - circumrenal contrast extravasation
      - non-opacification of ipsilateral ureter

  - intra-op, "single-shot" IVP } not very sensitive
  - retrograde pyelogram } mainly to Dx missed ureteral injuries or further stage ureteral injuries seen on CT/IVP

- **causes of ureteral trauma**
  - **penetrating truma**
  - **blunt truma**
  - **iatrogenic”mot common”**
  - hysterectomy (54%)
  - colorectal surgery (15%)
  - pelvic surgery (eg ovarian tumour removal and transabdominal urethropexy)
  - lap gyne surgery (eg lysis of endometriosis)
  - abdominal vascular surgery
  - urologic surgery (eg ureteroscopy)

- **present**
  - 25-45% do not have even microscopic hematuria
  - must have high index of suspicion based on mechanism and location of injury
  - most patients with ureteric injury have significant associated injury and so often undergo laparotomy
  - ureteric injuries are often Dx’d intra-operatively
  - also often have a delayed presentation } bullet has ischemic effect on surrounding tissue that results in delayed injury
  - **delayed signs of ureteric injury** often present >48hrs after injury
    - fever
    - WBC
    - hydronephrosis
    - hematuria
    - local peritoneal irritation
    - ileus or N/V
    - urine leak/fistula
    - anuria

- **Management**
  - **ureteral contusions**
    - observation & conservative management
    - UU
      - severe or large areas of contusion often heal w/ stricture or slough later on resulting in necrosis

  - **for UPPER ureteric injuries**
    - UU } if short
    - ureterocalycostomy } for profound damage to the renal pelvis and UPJ
    - auto-Tx } for profound ureter loss or after multiple failed attempts at repair
    - bowel interposition
      - when long segments of ureter destroyed
      - ileal ureter, appendix, Yang-Monti
      - NOT good option for acute repair
      - avoid if renal insufficiency
    - chronic stent or NT changes
    - Nx
    - ?7) Flap procedures (eg Culp-DeWeerd, Scardino-Prince, etc)
  - **a LONG PROXIMAL ureteric stricture/defect**
    - Culp-DeWeerd Spiral Flap pyeloplasty
    - Scardino-Prince Vertical pyeloplasty
    - Davis intubated ureterotomy
    - ureterocalycostomy
    - Boari flap + Psoas Hitch
    - ileal interposition
    - renal descensus + UU
    - renal auto-Tx
    - chronic stent or NT changes
    - Nx

  - **MID ureteric injuries?**
    - UU +/- renal descensus
    - TUU } NOT good option for acute repair
    - bowel interposition
    - Boari flap } 3:1 length-to-width ratio (minimum 4cm base and 3cm tip of flap)
    - ureterocutaneous fistula
- **for DISTAL ureteric injuries**
  - ureteroneocystostomy (reimplant) } for very distal ureteric injuries
  - Lisch-Gregoire reimplant
  - Psoas Hitch } high success rate (>95%)
  - Boari flap } when long segment of distal ureter destroyed

- **partial transection of a ureter?**
  - primary repair
    - must be limited to stab wounds and low-velocity GSWs
    - convert longitudinal incision into transverse so as not to narrow lumen (Heineke-Mikulicz procedure)
    -
- **if the patient is too unstable to tolerate the OR time**
  - stage repair
    - do nothing but plan OR once stable (usually within 24hrs)
    - place ureteral stent and do nothing else
    - exteriorize the ureter (ureterocutaneous fistula)
    - tie off ureter & plan perc NT
  - Nx

- for iatrogenic ureteric injury
    - ligation
        - removal of ligature and observe ureter for viability
        - if viability is questionable, perform UU or reimplant
        - place stent by opening bladder or by cystoscopy
    - transection
        - immediate recognition
            - usually treated same as ureteral trauma (upper, mid, distal)
            - consider Nx if vascular graft surgery (urine leak around graft can be potentially fatal), although renal dysfunction after aortic aneurysmectomy ranges from 3-12%
        - delayed recognition
            - stent placement (successful only in 20-50%) x 6wks
            - early open repair (may run into more complications)
            - NT + delayed repair (>6weeks)
                - open repair vs endourologic repair
                - balloon dilation, laser incision, etc reserved for short strictures only
    - ureteroscopic avulsion
        - usually treated same as ureteral trauma
    - ureteroscopic perforation
        - stent placement (usually no complications)

- **the best time to repair a ureteric injury**
    - intraop Dx ·
        - immediate repair
    - <POD#5-7 at Dx
        - retrograde + stent preferred
        - immediate repair ok if complex
    - if >POD#5-7 at Dx
        - stent or NT

        - drain urinoma
        - delayed reconstruction

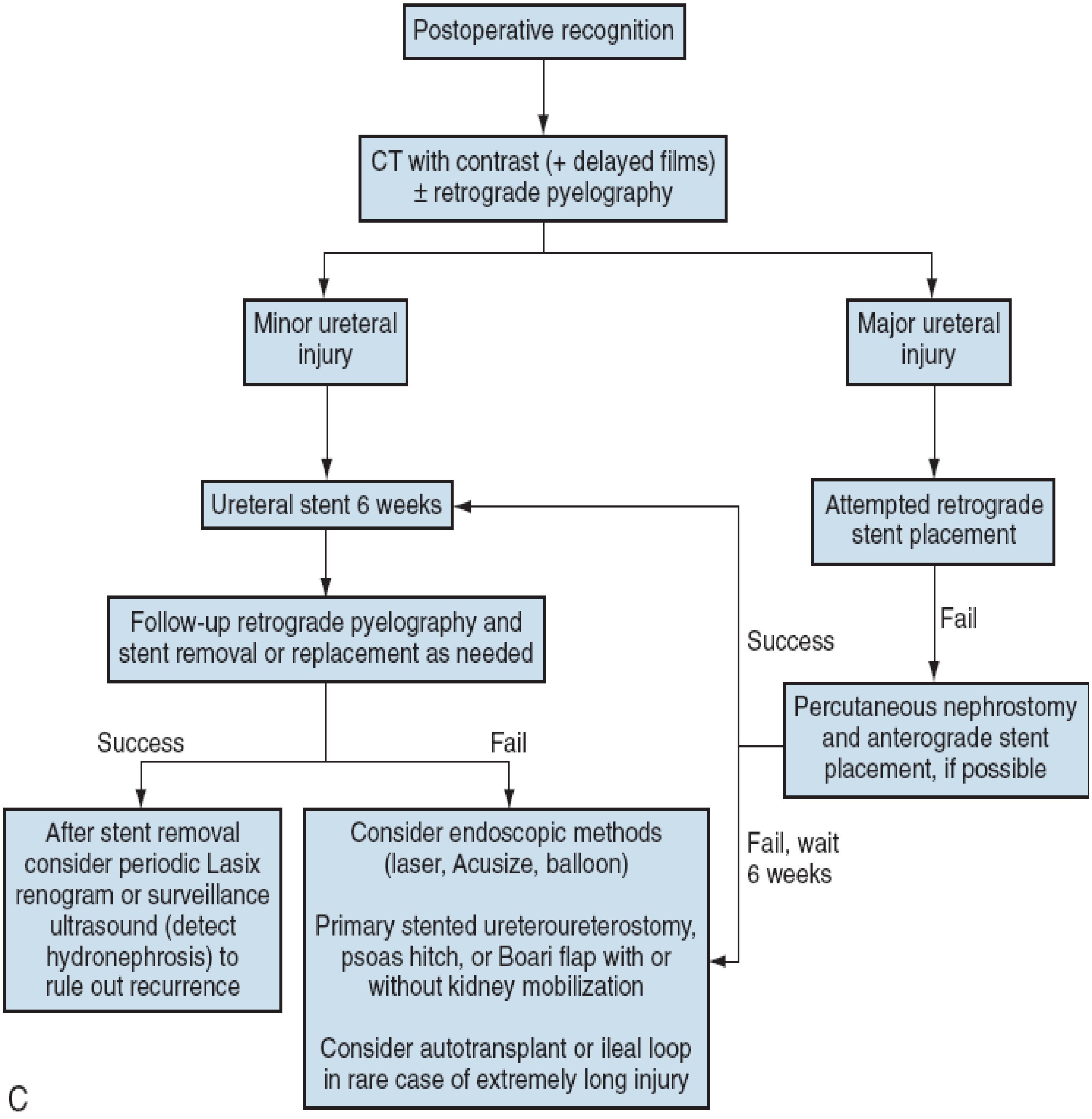
- **follow-up management of repaired ureteric injuries/trauma**
    - stent left in situ at least 6 weeks
    - consider retrograde pyelogram at time of stent removal
    - lasix renal scan and/or U/S at 4-6 weeks (or earlier if symptoms develop)
    - surveillance with lasix renal scan and/or U/S
    - if 6 weeks of stenting is unsuccessful
        - endoscopic treatment
        - laser incision, balloon dilation, etc
        - if unsuccessful, consider open repair

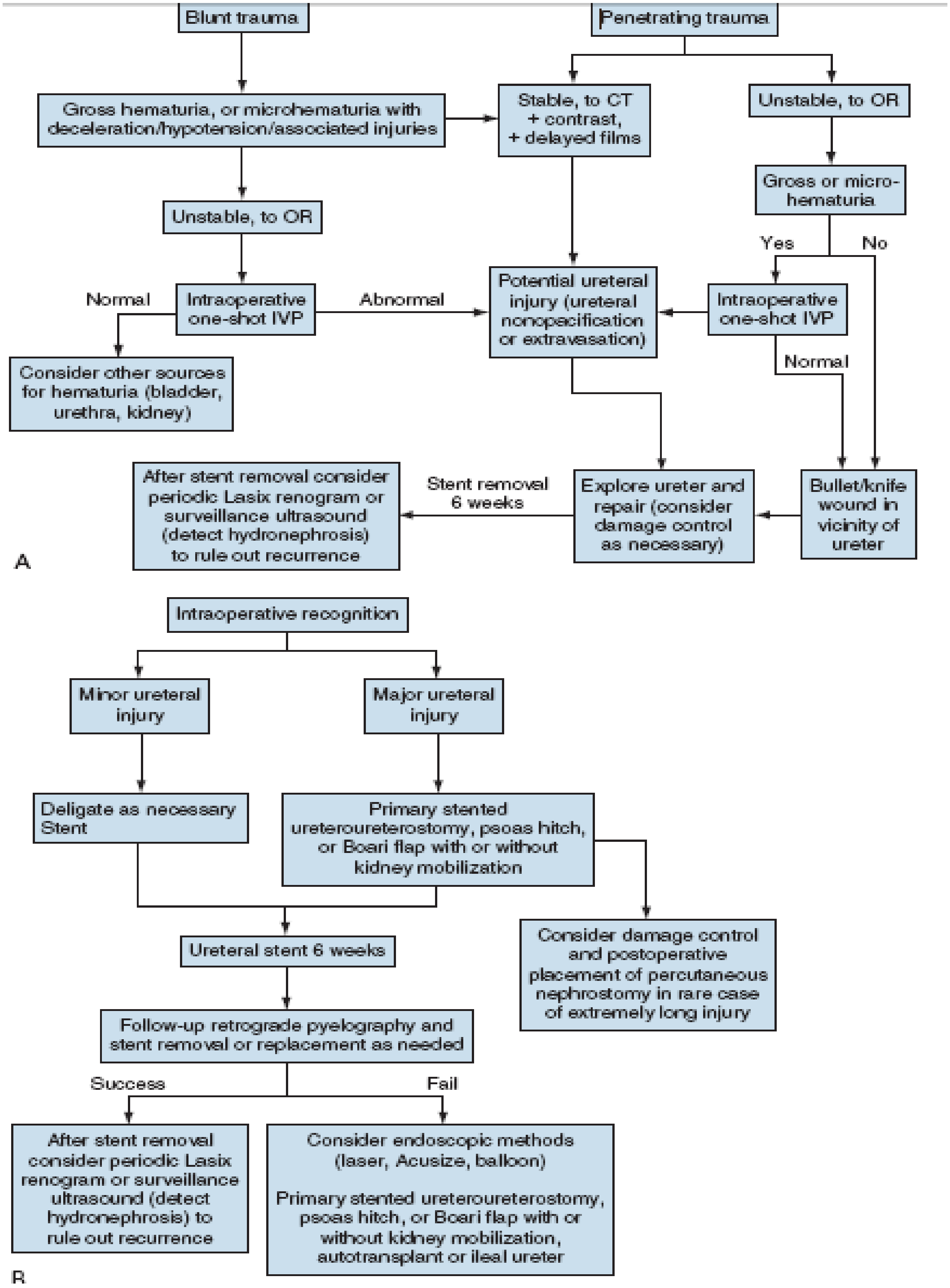
- **Indications for Nx after ureteral injuries**
    - severe associated visceral injuries
    - severe ipsilateral renal injury + repair not possible
    - poor renal function after delayed Dx
    - severe pan-ureteric injury
    - persistent ureteral fistula
    - ureteral injury during vascular graft placement
        - relative indication now most will try to save kidney
            - repair, stent, omental wrap +/- drain

DDx of non-visualization of one kidney during IVP

- absence of kidney
    - congenital agenesis
    - ectopic kidney
    - Nx
- decreased perfusion
    - systemic hypoTN

    - unilateral renal vein thrombosis
    - renal artery occlusion /thrombosis
    - pedicle avulsion (trauma)
- high-grade obstruction } chronic obstructive uropathy
- replaced normal renal parenchyma
    - MCDK
    - renal tumour
    - XGP
    - chronic pyelonephritis


Postoperative recognition
CT with contrast (+ delayed films) ± retrograde pyelography
Minor ureteral injury
Major ureteral injury
Ureteral stent 6 weeks
Attempted retrograde stent placement
Fail
Follow-up retrograde pyelography and stent removal or replacement as needed
Success
Percutaneous nephrostomy and anterograde stent placement, if possible
Success
Fail
After stent removal consider periodic Lasix renogram or surveillance ultrasound (detect hydronephrosis) to rule out recurrence
Consider endoscopic methods (laser, Acusize, balloon)
Primary stented ureteroureterostomy, psoas hitch, or Boari flap with or without kidney mobilization
Consider autotransplant or ileal loop in rare case of extremely long injury
Fail, wait 6 weeks
C


Blunt trauma
Penetrating trauma
Gross hematuria, or microhematuria with deceleration/hypotension/associated injuries
Stable, to CT + contrast, + delayed films
Unstable, to OR
Gross or micro-hematuria
Unstable, to OR
Yes
No
Normal
Intraoperative one-shot IVP
Abnormal
Potential ureteral injury (ureteral nonopacification or extravasation)
Intraoperative one-shot IVP
Consider other sources for hematuria (bladder, urethra, kidney)
Normal
After stent removal consider periodic Lasix renogram or surveillance ultrasound (detect hydronephrosis) to rule out recurrence
Stent removal 6 weeks
Explore ureter and repair (consider damage control as necessary)
Bullet/knife wound in vicinity of ureter
A
Intraoperative recognition
Minor ureteral injury
Major ureteral injury
Deligate as necessary Stent
Primary stented ureteroureterostomy, psoas hitch, or Boari flap with or without kidney mobilization
Ureteral stent 6 weeks
Consider damage control and postoperative placement of percutaneous nephrostomy in rare case of extremely long injury
Follow-up retrograde pyelography and stent removal or replacement as needed
Success
Fail
After stent removal consider periodic Lasix renogram or surveillance ultrasound (detect hydronephrosis) to rule out recurrence
Consider endoscopic methods (laser, Acusize, balloon)
Primary stented ureteroureterostomy, psoas hitch, or Boari flap with or without kidney mobilization, autotransplant or ileal ureter
B

BLADDER INJURIES

Incidence

- 10**-30% have concomitant urethral injuries**

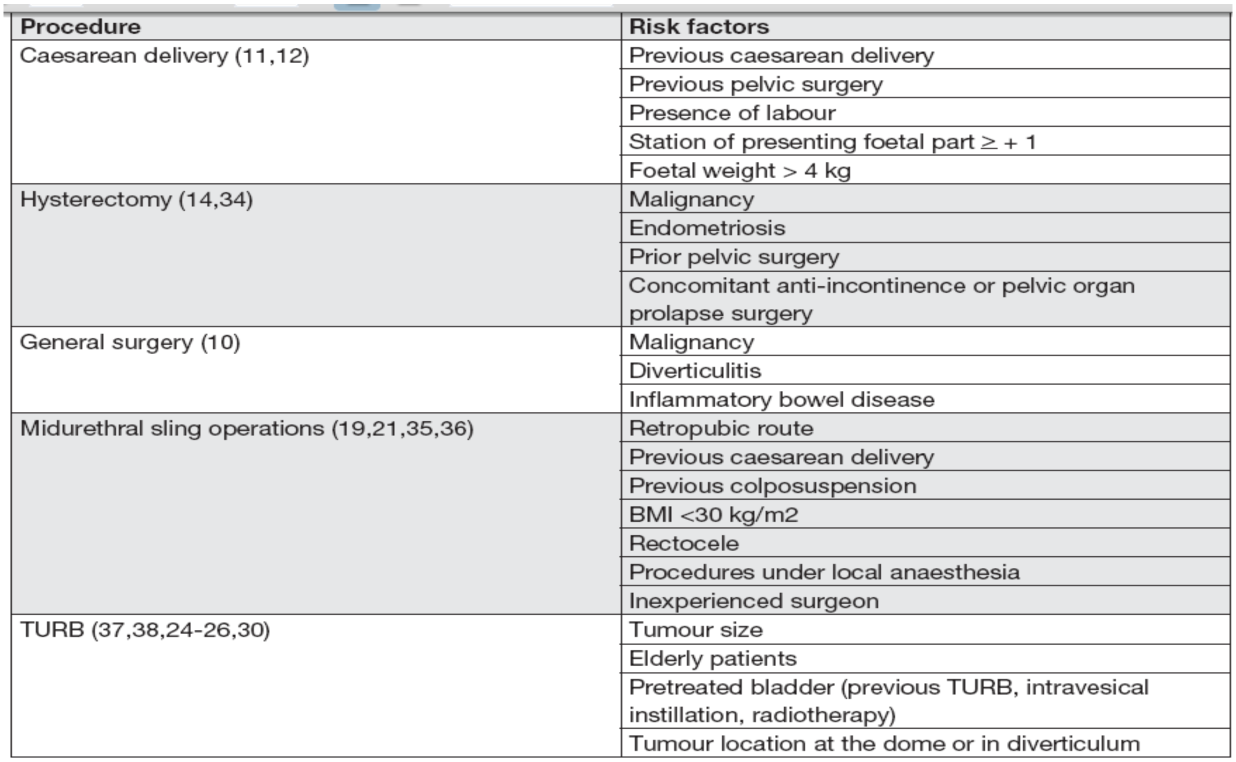
Causes of bladder injury

1) blunt trauma

- mostly from rapid deceleration MVCs, falls, crush injuries, etc
- **pelvic fracture associated with ~90% of bladder injuries**
- **only 5-10% of pelvic fractures have bladder injuries**

2) penetrating trauma   GSWs and stabbings

3) iatrogenic injury   Obs/Gyne complications are the most common



Procedure	Risk factors
Caesarean delivery (11,12)	Previous caesarean delivery
	Previous pelvic surgery
	Presence of labour
	Station of presenting foetal part ≥ + 1
	Foetal weight > 4 kg
Hysterectomy (14,34)	Malignancy
	Endometriosis
	Prior pelvic surgery
	Concomitant anti-incontinence or pelvic organ prolapse surgery
General surgery (10)	Malignancy
	Diverticulitis
	Inflammatory bowel disease
Midurethral sling operations (19,21,35,36)	Retropubic route
	Previous caesarean delivery
	Previous colposuspension
	BMI <30 kg/m2
	Rectocele
	Procedures under local anaesthesia
	Inexperienced surgeon
TURB (37,38,24-26,30)	Tumour size
	Elderly patients
	Pretreated bladder (previous TURB, intravesical instillation, radiotherapy)
	Tumour location at the dome or in diverticulum

4) spontaneous   altered sensorium

Classification of bladder injuries

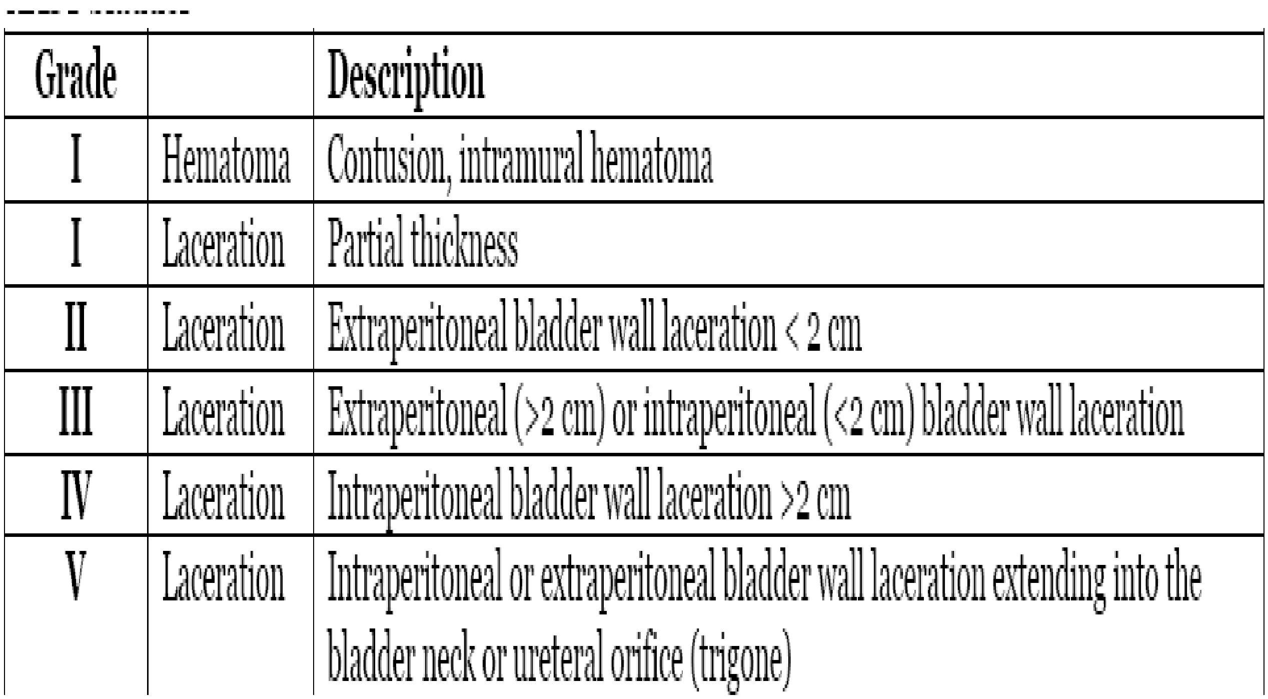
1) contusions

2) extraperitoneal (65%) “most common”

3) intraperitoneal (25%)

4) combined extraperitoneal & intraperitoneal (10%)

Another classification



Grade		Description
I	Hematoma	Contusion, intramural hematoma
I	Laceration	Partial thickness
II	Laceration	Extraperitoneal bladder wall laceration < 2 cm
III	Laceration	Extraperitoneal (>2 cm) or intraperitoneal (<2 cm) bladder wall laceration
IV	Laceration	Intraperitoneal bladder wall laceration >2 cm
V	Laceration	Intraperitoneal or extraperitoneal bladder wall laceration extending into the bladder neck or ureteral orifice (trigone)

Presentation

External truma

- **gross hematuria or clots in urine } present in >90%**
- S/P tenderness or pain
- lower abdo bruising or signs of perineal or genital trauma
- abdo distension or ileus or decreased bowel sounds
- inability to void or low u/o
- Extravasation of urine may result in
    - swelling in the perineum, scrotum (through the inguinal canal), and thighs
    - swelling in anterior abdominal wall within the potential space between the transversalis fascia and the parietal peritoneum

Iatrogenic trauma

Perioperative: external iatrogenic bladder trauma

- extravasation of urine,
- visible laceration,
- clear fluid in the surgical field,
- appearance of the bladder catheter,
- blood and/ or gas in the urine bag during laparoscopy
- Intravesical instillation of methylene blue may be helpful
- If bladder perforation is present, the integrity of the ureteric orifices should be checked

Perioperative: internal iatrogenic bladder trauma

- Fatty tissue,
- the visualisation of bowel suggests perforation
- inability to distend the bladder,
- a low return of irrigation fluid,
- abdominal distension

Postoperative: unrecognised bladder injury

- haematuria,
- lower abdominal pain,
- abdominal distension,
- ileus,
- peritonitis,
- sepsis,
- urine leakage from the wound,
- decreased urinary output,
- increased serum creatinine

Investigation

1. **cystography**
    - **indications**
        - gross hematuria + pelvic fracture   30% have bladder rupture
        - gross hematuria + blunt trauma
        - microhematuria + pelvic fracture
        - high index of suspicion for bladder injury
        - penetrating trauma of pelvis/lower abdomen + any degree of hematuria
        - hx of prior bladder augmentation

microscopic hematuria alone is not an indication

- **technique**
    - fill until patient feels discomfort or until 350mL
        - 30% contrast (no dilution)
        - fill by gravity
    - 3 views taken pre-fill film, full bladder AP, and drainage films

- **findings on cystogram**
    - extraperitoneal
        - flame-shaped collection of contrast in pelvis
        - may extend up retroperitoneum or down into scrotum or perineum
    - intraperitoneal
        - contrast outlines loops of bowel

2. **CT cystograms "the best"**
    - bladder must be filled retrogradely to a volume of 350-400mL
    - **antegrade filling of bladder after clamping is NOT ADEQUATE**
    - no drainage films needed
    - posterior injuries can be seen

3. **Ultrasound**

- Ultrasound alone is insufficient in the diagnosis of bladder trauma

management of bladder injuries

1- **External truma**

- extraperitoneal
    - conservative management in most cases with catheter drainage
        - cystogram at 14days prior to removal of Foley
        - Abx until 3 days after Foley removal
- intraperitoneal
    - open repair (intravesical approach)
        - avoid entering pelvic hematoma } stay midline
        - inspect UO for clear efflux if injury suspected, stent or reimplant
        - JP drain
        - peri-op Abx for 3 days and then when foley removed
        - S/P drainage not necessary } urethral catheter adequate
        - cystogram after 7-10 days prior to removal of Foley

- *Bladder injuries with avulsion of lower abdominal wall or perineum and/or bladder tissue loss*
    - direct closure resulting in ischemia and eventual break-down of the repair. Therefore,. Use of a pedicled vastus lateralis myocutaneous flap

indications for immediate open repair of a bladder injury

- intraperitoneal injury
- patient undergoing laparotomy for other reasons
- penetrating or iatrogenic injury
- BN injury
- rectal or vaginal injury
- bone fragments projecting into bladder
- inadequate bladder drainage or clots in urine
- unresolving gross hematuria
- open pelvic fracture
- pelvic fracture needing ORIF

2- iatrogenic injuries

- Perforations recognised intraoperatively are primarely closed.
- For bladder injuries not recognised during surgery
    - intraperitoneal injuries,
        - surgical exploration with repair “the standard of care”
        - conservative management In selected cases with no sign of peritonitis
            - continuous bladder drainage
            - antibiotic prophylaxis
            - placement of an intraperitoneal drain
    - For extraperitoneal injuries,
        - onservative treatment with bladder drainage and antibiotic prophylaxis.
        - Large extraperitoneal perforations complicated by symptomatic extravesical collections require drainage, with or without closure of the perforation

- If bladder perforation is encountered during midurethral sling or transvaginal mesh procedures, sling reinsertion and urethral catheterisation (1–2 d) should be performed.
- For perforated or eroded meshes, cystoscopic removal is performed or a cystotomy if that fails

URETHRAL INJURIES

Posterior Urethra injury

causes of posterior urethral injury

- pelvic fractures (PFUD)
  - 10% of males & 6% of females with pelvic #'s sustain urethral injuries
- shear injuries
  - due to blunt trauma and stretching at membranous urethra

part of the posterior urethra is most often injured is

- **bulbomembranous junction**
  - fixed at UG diaphragm and puboprostatic ligaments
  - membranous urethral sphincter usually avulsed intact and remains functional
- in kids, injuries extend proximally to BN due to rudimentary prostate

classification of urethral injuries

- type I } urethral **stretch** injuries
- type II } membranous urethral **disruption proximal to GU diaphragm**
- type III } membranous urethral **disruption both proximal and distal to GU diaphragm**

another classification

- class 1 } blood at meatus, but normal imaging
- class 2 } stretch injury
- class 3 } partial disruption (contrast goes into bladder)
- class 4 } complete disruption with separation <2cm
- class 5 } complete disruption with separation ≥2cm or if concomitant vaginal, rectal, prostatic involvement

another classification

- class 1 } urethral stretch injury
- class 2 } membranous urethral disruption proximal to GU diaphragm
- class 3 } membranous urethral disruption proximal & distal to GU diaphragm
- class 4a } BN disruption into proximal urethra
- class 4b } BN disruption into bladder base
- class 5 } anterior urethral injury

presentation

- History
  - inability to void
  - pelvis fracture
  - straddle injury
  - gross hematuria
- Physical
  - blood at meatus (50%)
  - palpably full bladder
  - "high-riding" prostate
  - inability to pass urethral catheter
  - "butterfly" perineal hematoma (late finding)
    - boundaries that define a "butterfly" hematoma?
      - **must have rupture of Buck's fascia to get Butterfly distribution**
      - **contained by Dartos/Colles' fascia**
      - lateral inferior pubic rami and fascia lata of thigh
      - anteriorly can go up to clavicles (dartos continuous with Scarpa's)
      - posteriorly perineal body

complications of posterior urethral injuries

- ED 30-60%
- 2) incontinence 2-4%
- 3) anejaculation 2-4%
- 4) areflexic bladder 2-10%
- 5) fistulae
- 6) strictures
- 7) periurethral abscess
- 8) urethral diverticulum

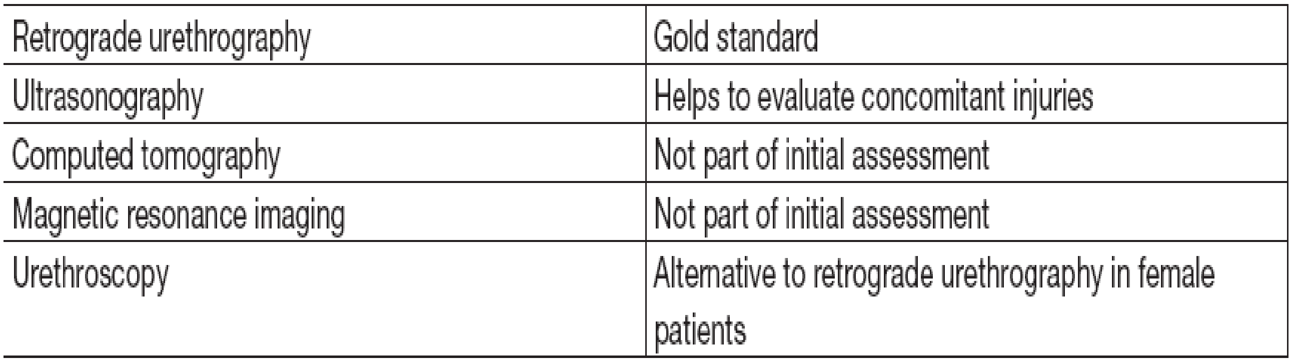
investigation

1) **RUG**

   Technique

   - unlubricated 14-16Fr catheter placed into fossa navicularis
   - gently inflate balloon until snug } can also use a Brodney clamp
   - place patient in oblique position
     - ~30 degrees
     - upper leg straight, lower leg flexed at hip & knee
   - scout film
   - inject 30% contrast at 10-20cc increments and take film
   - fluoro preferred over static films

2) **in women with suspected urethral injury, direct urethroscopy preferred over RUG**



Retrograde urethrography	Gold standard
Ultrasonography	Helps to evaluate concomitant injuries
Computed tomography	Not part of initial assessment
Magnetic resonance imaging	Not part of initial assessment
Urethroscopy	Alternative to retrograde urethrography in female patients

management

A. initial management of posterior urethral injuries

1- gentle attempt at placement of catheter
   - DOES NOT convert incomplete to complete injury

2- S/P tube placement is gold standard
   - worse outcomes if S/P only without primary realignment } if unstable, no choice

3- attempt 1° realignment in stable patients
   - NOT INDICATED for STRADDLE INJURIES
   - antegrade vs retrograde
   - avoid prolonged endoscopic realignment attempts increases risk of infecting pelvic hematoma
   - 1° realignment decreases risk of complete stenosis, results in milder strictures, and makes future urethroplasty easier

   Follow up after 1ry realignment
   - VCUG and pericatheter RUG at 4-6 weeks
     - remove catheter if no extravasation
     - remove S/P tube once patients voids well for 7-14 days

4- immediate open primary realignment NOT RECOMMENDED
   - higher rates of ED, incontinence, stricture formation, and operative blood loss

indicated in

- bladder neck injury
- in patient who undergo open surgery for the associatd rectal or internal bone fiation

Management of female urethral disruption

- **immediate primary repair or at least realignment over a catheter**
  - avoids subsequent urethrovaginal fistulas or urethral obliteration
  - delayed reconstruction too difficult because short urethra (4cm) not amenable to anastomotic repair when embedded in scar
- close any concomitant vaginal lacerations to prevent vaginal stenosis

B. delayed repair of a posterior urethral disruption

- **time**
    - **after 3 months as scar tissue stable**
    - once patient stable and ambulatory, can attempt posterior urethroplasty
        - patient must be able to tolerate positioning for OR (exaggerated lithotomy)

- **pre -op w/u for delayed posterior urethroplasty after posterior urethral injury?**
    - RUG + VCUG
        - once BN opens, prostatic urethra should be visualized enabling measurement of distance between ends of disrupted urethra
        - if BN doesn't open, urethroscopy is used to assess defect
        - **appearance of BN on pre-op imaging (open or closed) DOES NOT correlate well**
        - **with BN function post-op**
    - MRI
        - can characterize defect length and direction of dislocation

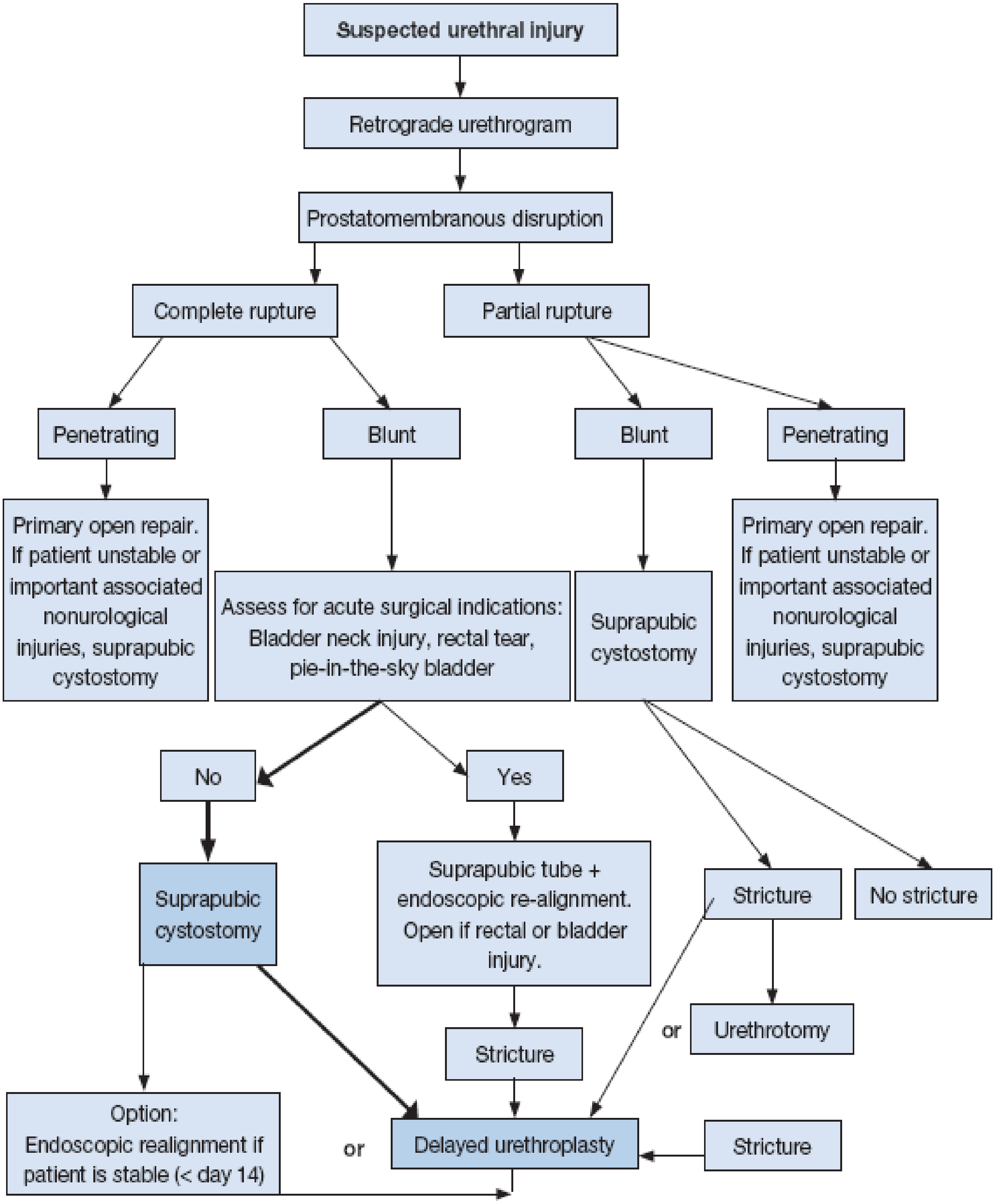
- **options for definitive management**
    - **delayed 1ry urethroplasty after 2 week "not recommended"**
    - endoscopic treatments eg VIU
        - for short strictures after successful primary realignment
        - **not recommended if stricture >1cm**
        - "cut-to-light" procedures have poor results with high complication rates
    - posterior urethroplasty **treatment of choice**
        - **must wait ~3months for scar to stabilize)**
        - excise all scar tissue from proximal urethra until 28Fr bougie passes without resistance
        - bulbar urethra anastomosed to prostatic urethra in tension-free manner
        - **can gain length by several methods:**
            - mobilize bulbar urethra

        - separation of corporal bodies
        - inferior pubectomy
        - corporal rerouting
    - **perineal approach is preferred**
        - **indications for combined abdominoperineal approach (+/- partial pubectomy)?**
            - severe fibrosis
            - previous failed anastomotic urethroplasty
            - associated BN injury
            - kids

outcomes of posterior urethroplasty after posterior urethral injury

- 12-15% have recurrent stenosis at the anastomosis
- • VIU often successful in this setting

In penetrating injury 1ry repair is an option and preferred


Suspected urethral injury
Retrograde urethrogram
Prostatomembranous disruption
Complete rupture
Partial rupture
Penetrating
Blunt
Blunt
Penetrating
Primary open repair. If patient unstable or important associated nonurological injuries, suprapubic cystostomy
Assess for acute surgical indications: Bladder neck injury, rectal tear, pie-in-the-sky bladder
Suprapubic cystostomy
Primary open repair. If patient unstable or important associated nonurological injuries, suprapubic cystostomy
No
Yes
Suprapubic cystostomy
Suprapubic tube + endoscopic re-alignment. Open if rectal or bladder injury.
Stricture
No stricture
Urethrotomy
or
Stricture
Option: Endoscopic realignment if patient is stable (< day 14)
or
Delayed urethroplasty
Stricture

Posterior urethral injury in male

Anterior Urethra injury

causes

- straddle injury most common the relatively immobile bulbar urethra is trapped and compressed against the inferior surface of the symphysis pubis.
- penetrating injury to penile urethra less common
- endoscopic instrument or urethral catheter foreign objects
- constriction device for urinary incontinence and then forget to release the band can cause severe ischaemic injuries .espicially in paraplegic due to loss of sensation

classification

- contusion
- incomplete disruption
- complete disruption

presentation

- blood at meatus
- perineal hematoma
- gross hematuria
- urinary retention
- blood and urinary extravasation into scrotum } severe trauma

initial management of anterior urethral injuries

- contusions & incomplete disruptions   urethral catheter diversion alone
- complete disrubtion
  - Blunt anterior urethral injuries
    - simply suprapubic diversion is the best as it is associated with spongiosal contusion, which makes it more difficult to evaluate the limits of urethral debridement in the acute phase.
    - delayed reconstruction
  - in penetrating truma
    - high-velocity GSWs

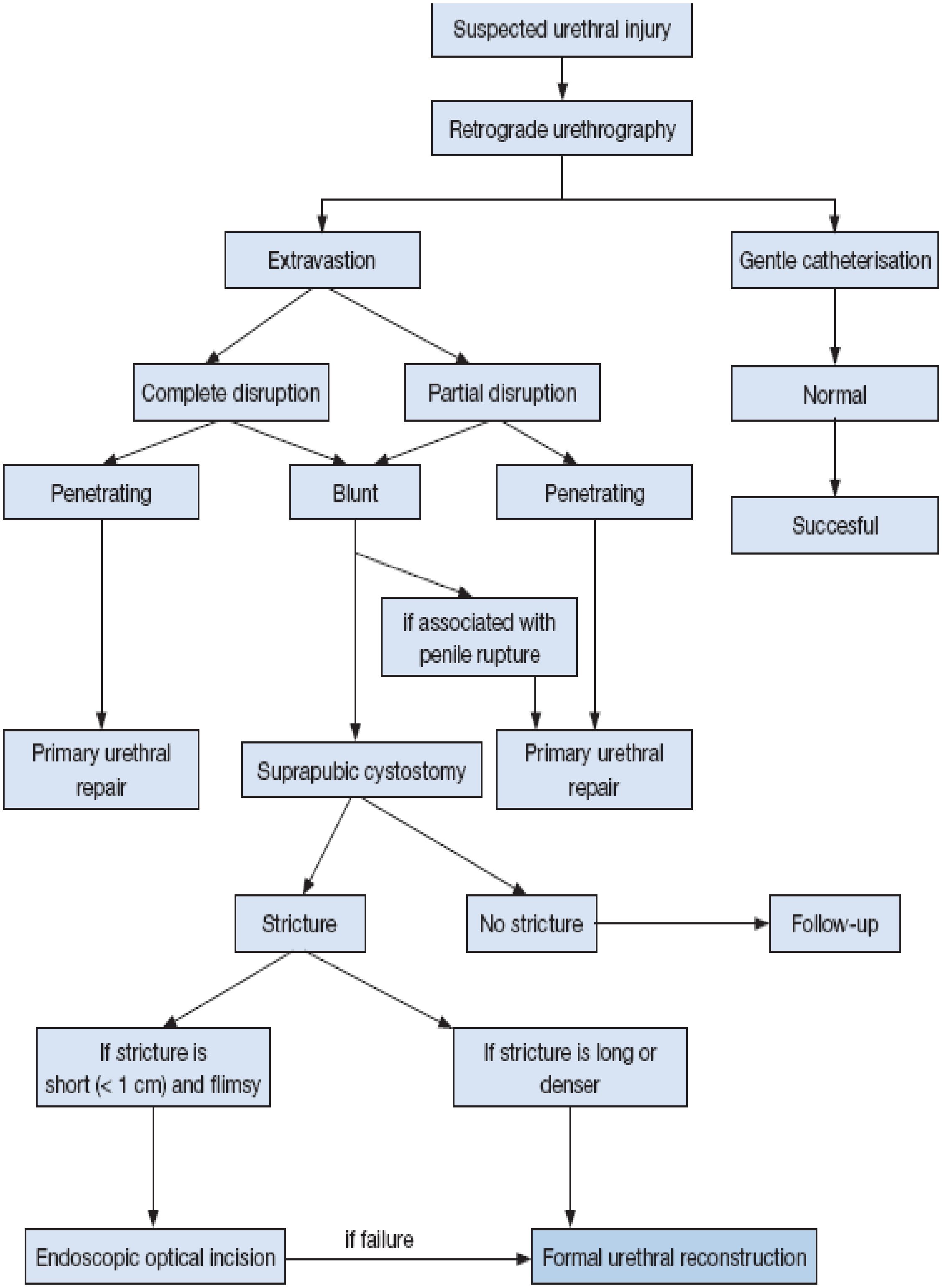
        - S/P tube placement
        - delayed reconstruction
    - low-velocity GSWs
        - primary surgical repair recommended
        - catheter alignment alone has high stricture rate

pre-op w/u for delayed anterior urethroplasty

- RUG + VCUG } characterize obliterated urethra
- urethral U/S also can delineate length and severity of stricture

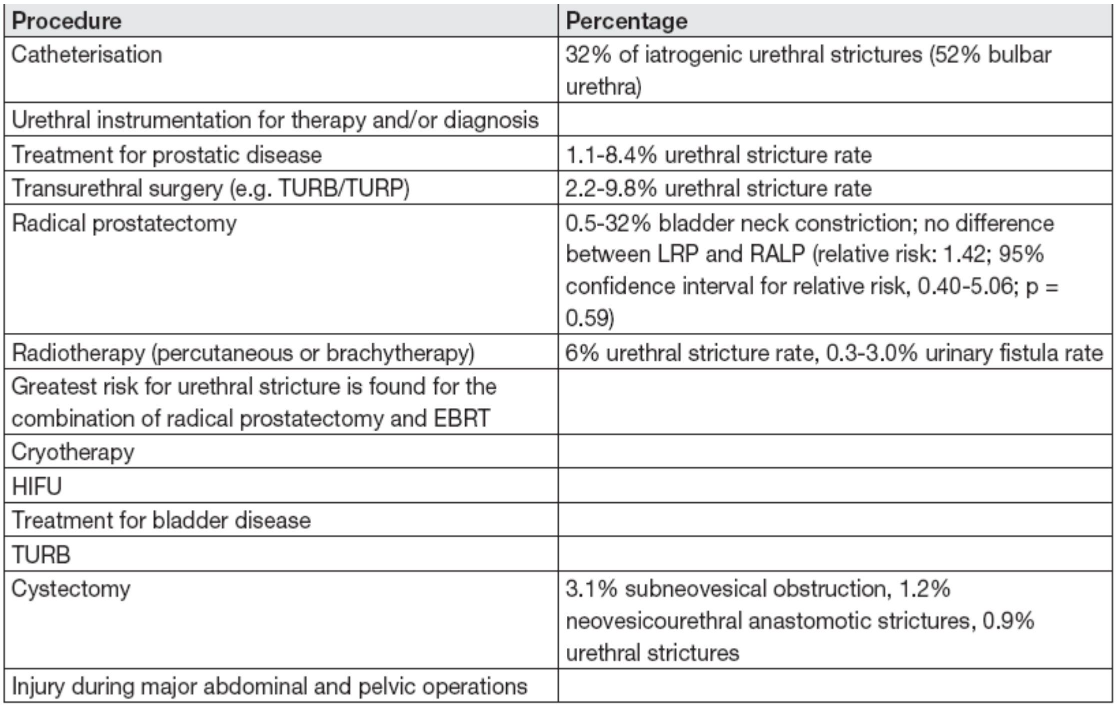
Definitive management

    - VIU if less than 1 cm
    - Longer strictures of the anterior urethra should not be repaired by an end-to-end anastomosis in order to avoid chordee. In these cases, flap/graft urethroplasty is indicated. Usually at 3-6 months



Anterior urethral injury in male

Causes of Iatrtogenic urethral injury



Procedure	Percentage
Catheterisation	32% of iatrogenic urethral strictures (52% bulbar urethra)
Urethral instrumentation for therapy and/or diagnosis	
Treatment for prostatic disease	1.1-8.4% urethral stricture rate
Transurethral surgery (e.g. TURB/TURP)	2.2-9.8% urethral stricture rate
Radical prostatectomy	0.5-32% bladder neck constriction; no difference between LRP and RALP (relative risk: 1.42; 95% confidence interval for relative risk, 0.40-5.06; p = 0.59)
Radiotherapy (percutaneous or brachytherapy)	6% urethral stricture rate, 0.3-3.0% urinary fistula rate
Greatest risk for urethral stricture is found for the combination of radical prostatectomy and EBRT	
Cryotherapy	
HIFU	
Treatment for bladder disease	
TURB	
Cystectomy	3.1% subneovesical obstruction, 1.2% neovesicourethral anastomotic strictures, 0.9% urethral strictures
Injury during major abdominal and pelvic operations	

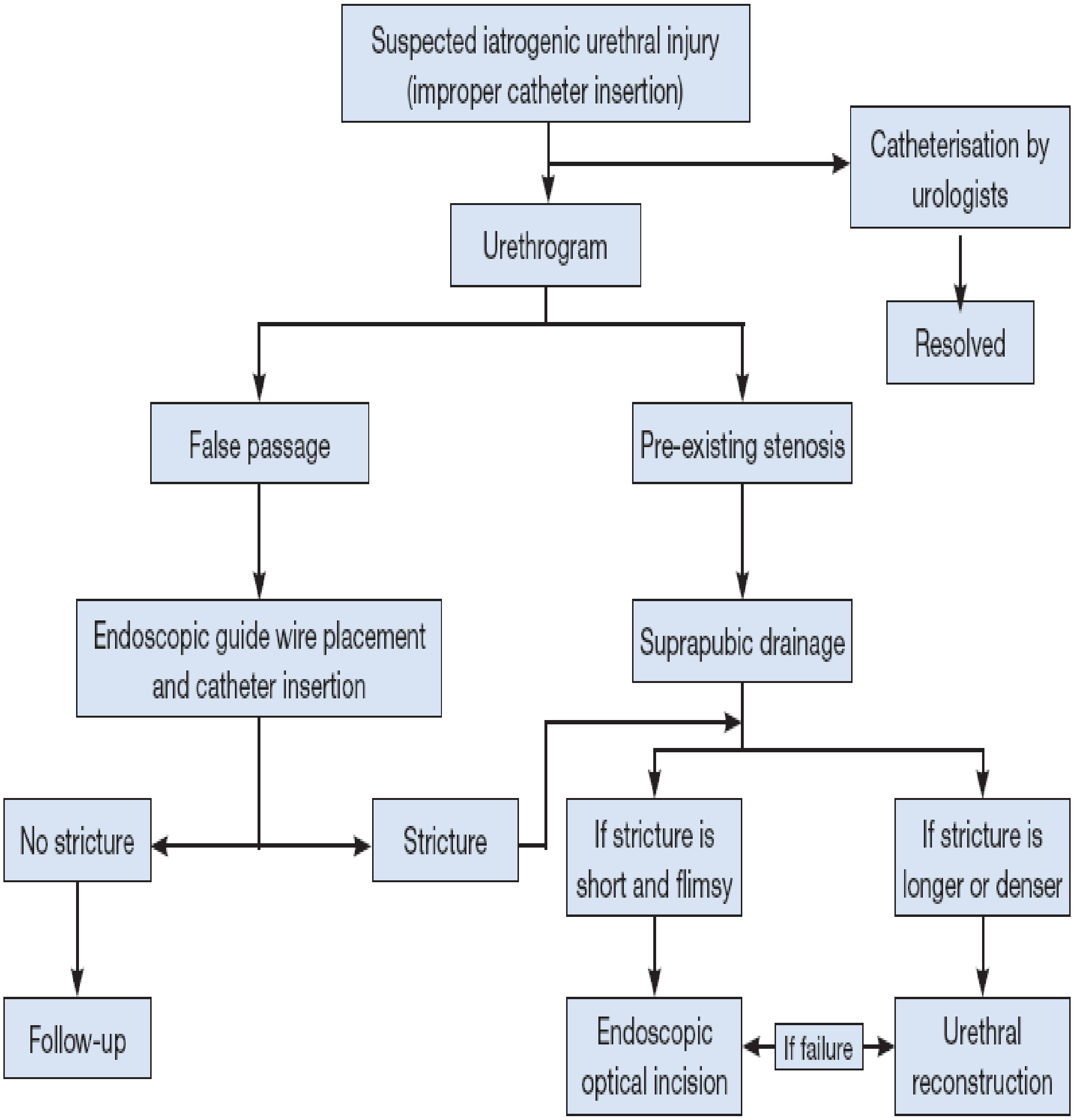
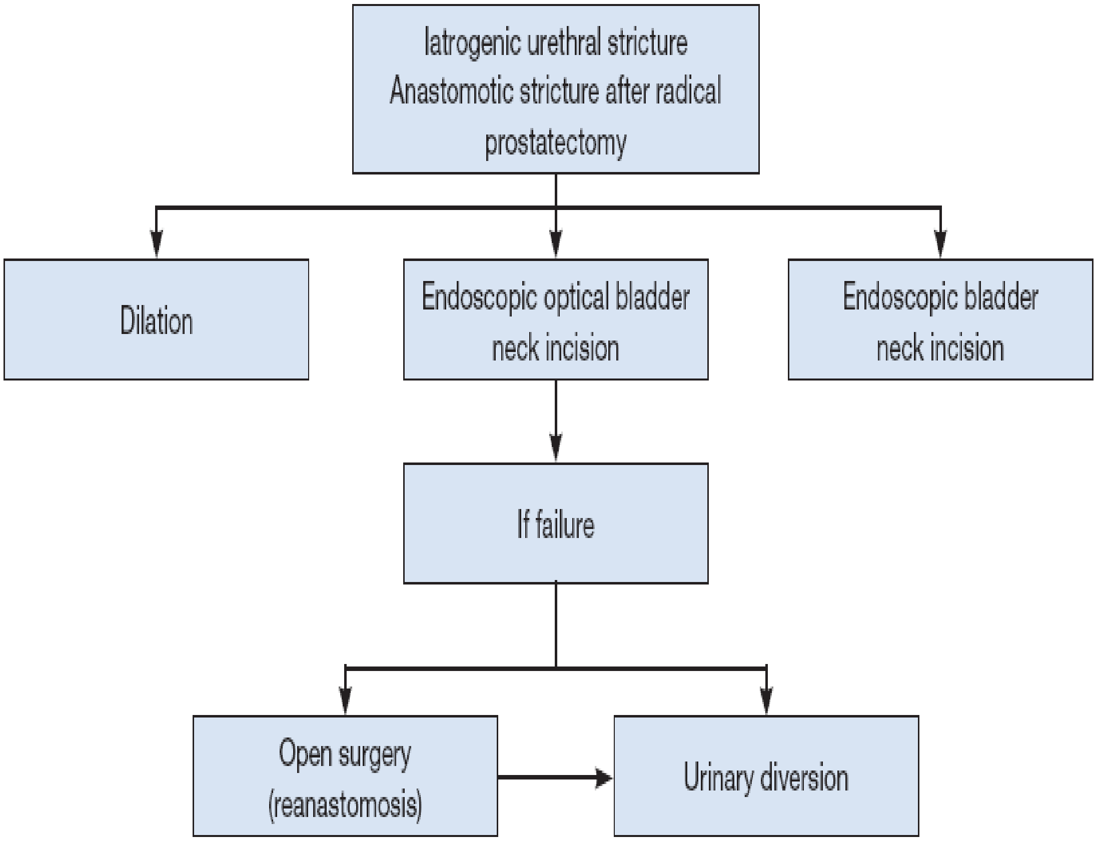

Suspected iatrogenic urethral injury (improper catheter insertion)
Catheterisation by urologists
Resolved
Urethrogram
False passage
Pre-existing stenosis
Endoscopic guide wire placement and catheter insertion
Suprapubic drainage
No stricture
Stricture
If stricture is short and flimsy
If stricture is longer or denser
Follow-up
Endoscopic optical incision
If failure
Urethral reconstruction

Figure 9: Flow diagram of treatment for stricture after radical prostatectomy


Iatrogenic urethral stricture
Anastomotic stricture after radical prostatectomy
Dilation
Endoscopic optical bladder neck incision
Endoscopic bladder neck incision
If failure
Open surgery (reanastomosis)
Urinary diversion

INJURIES OF THE EXTERNAL GENITALIA

Penis

a) penile fracture

definition

it is **tear in tunica albuginea** bilaminar structure (inner circular & outer longitudinal) outer is strength layer

Cause

- trauma to the erect penis during
  - sexual intercourse,
  - masturbation,
  - rolling over in bed (rarely)
- self-inflicted bending to produce detumescence in some Middle Eastern Cultures

pathophysiology

The thickness of the tunica albuginea in the flaccid state (approximately 2 mm) decreases in erection to 0.250.5mm, and is therefore more vulnerable to traumatic injury

The most common mechanism of injury is when the penis slips out of the vagina and strikes against the symphysis pubis or perineum

- tunical tear is usually transverse & unilateral

- rupture can occur anywhere, but most are distal to suspensory ligament

- **rupture of dorsal penile artery or vein during intercourse may mimic penile #**

Presentation

1) history

- sudden detumescence after pop or crack is heard
- pain and discoloration follow, with swelling of penile shaft
- eggplant deformity seen when Buck’s fascia remains intact

2) P/E

- swollen, ecchymotic penis (often deviates away from side of rupture)
- swelling, bruising may extend to scrotum, perineum, S/P region if Buck’s fascia not intact
- tunical tear not always palpable

3) imaging not usually necessary

- cavernosography is very time-consuming and hard to interpret
- U/S is easy and cheap but has high false negative rate
- MRI is very accurate in showing tunical rupture but labour intensive
- • if equivocal, MRI would be first line evaluation

management

1) **early exploration & surgical repair has been shown to be of most benefit**

- distal circumcising incision and degloving of penis
- closure of tunical defect with interrupted 2-0 or 3-0 absorbable suture
- avoid deep corporal vascular ligation and excessive debridement of delicate erectile tissue
- concomitant urethral injuries should be repaired
  - • oversew partial injuries over catheter
  - • debride, mobilize, and repair complete injuries over catheter

2) Abx

3) 1 month abstinence

b) GSWs to the penis

- **80% have other associated injuries**
  - abdominal, pelvis, lower extremity, vascular, inguinal, other GU
- 15-50% have urethral injuries
  - strongly consider RUG for patients w/ penetrating injury to penis (blood at meatus, difficulty voiding, close to urethra, etc)
  - repair of all urethral injuries should follow standard urethroplasty principles
  - if injury is extensive, often need staged repair + urinary diversion

management

- immediate exploration
- copious irrigation
- excision of foreign matter
- Abx prophylaxis
- surgical closure

c) bites to the penis

- dog bites most common
  - copious irrigation + debridement
  - immediate primary closure
  - prophylactic ABx
  - • Keflex + PenV (500mg qid) for *Pasteurella multocida*
  - tetanus + rabies immunization
- human bites
  - usually present later than animal bites, so often infected
  - similar Rx as animal bites but need to cover *Eikenella corrodens*
  - • **DO NOT CLOSE HUMAN BITES PRIMARILY**
  -

d) penile amputation

- if acute presentation, microvascular replantation is treatment of choice

- • if no micro surgeon available, transfer to another institution
- clean and wrap amputated portion in sterile NS-soaked gauze then put in sterile bag
- **can re-implant up to ~18hrs**
- 2 layer spatulated urethral anastomosis over catheter
- **microvascular repair of dorsal artery, vein & nerves preferred**
- repair tunica albuginea with interrupted sutures
- coverage with native skin
- S/P tube
- if microvascular surgeon unavailable, replantation using McRoberts principles +/- leeches

- if amputated portion is unavailable,

- close corporal bodies with 4-0 PDS
- spatulate urethral meatus to tunica
- cover penile shaft (+/- STSG) } can also bury shaft under skin of scrotum
- delayed phallic reconstruction or penile reconstruction

- consider psych consult if self-inflicted (most cases –65-90%)

key steps to penile replantation

- 2 layer urethral closure over catheter with 5-0 absorbable suture
- minimal dissection along neurovascular bundle to identify severed vessels and nerves
- closure of tunica albuginea with 3-0 absorbable suture
- microscopic anastomosis of dorsal artery with 11-0 nylon
- microscopic repair of dorsal vein with 9-0 nylon
- microscopic epineural repair of dorsal nerve with 10-0 nylon
- S/P cystostomy

successful is penile replantation after traumatic amputation

- 50% able to achieve erections
- sensation present in 80% after microscopic replantation

complications of penile replantation

less common with microvascular repair

- urethral strictures
- loss of appendage
- skin loss
- infection
- sensory abnormalities
- chordee
- ED

e) zipper injuries of the penis

- penile block
- lubricate sliding piece and adjacent skin with mineral oil
- one attempt to unzip
- cut cloth material between each tooth to release device
- bone cutter can be used to cut slide piece to allow zipper to fall apart
- some kids may need Cx or an elliptical skin excision under GA

f) strangulation injuries of the penis

- decompress constricted penis to allow blood flow and urination
- lubrication, bolt cutters, drills, etc may be needed

Testis

factors protect the testis from injury

- scrotal mobility
- reflex cremasteric muscle contraction
- tough fibrous tunica albuginea

causes of testis trauma

- 75% blunt trauma
  - assault, sports-related events, MVA
  - 1-2% are bilateral
- 25% penetrating trauma
  - GSWs, explosions, impalement injuries
  - 30% are bilateral
  - ~80% assoc'd w/ non-GU injuries (thigh, perineum, femoral vessels, etc)

Presentation

- physical exam
  - swelling & ecchymosis are variable
  - degree of hematoma does not correlate with severity of testis injury
  - absence of hematoma does not rule out testis rupture
  - **r/o concomitant urethral injury**
  - nonpalpable testis may represent a dislocated testis (outside of scrotum)

U/S to assess integrity and vascularity of testis

- • inhomogeneity of parenchyma + disruption of tunica albuginea suggest testis fracture
- • 80% of significant hematoceles are due to rupture, regardless of imaging

if U/S is equivocal but physical exam is suspicious, always explore

DDx of testis fracture

- hematocele without rupture
- testicular torsion
- reactive hydrocele
- hematoma of epididymis or spermatic cord
- intratesticular hematoma

management of testicular trauma

- **early exploration & repair is beneficial**

- scrotal incision preferred

- close tunica albuginea w/ absorbable sutures after removal of necrotic & extruded seminiferous tubules

- explore and drain intratesticular hematomas even in absence of testis rupture to prevent

pressure necrosis and atrophy, delayed exploration, and orchiectomy

- close tunica albuginea … leave tunica vaginalis open … consider drain

management of penetrating scrotal injuries

- explore to r/o vascular and vasal injury
- vas injured in 7-9% of scrotal GSWs
- ligate injured vas with nonabsorbable suture + delayed reconstruction prn

Haematocoele

- Conservative management is recommended in haematoceles smaller than three times the size of the contralateral testis
- In large haematoceles, requires surgery intervention

Genital skin

causes of genital skin loss

  - **Fournier's gangrene } most common cause of extensive genital skin loss**
  - traction by mechanical devices (farm or industrial machinery)
  - suction devices (vacuums)
  - burns } usually full thickness because skin so thin

Fournier's gangrene

Risk factor

- **D**M
- **S**urgery in local area
- **A**lcohol abuse
- **C**IC (urine extravasation)
- **M**alnutrition
- **R**oids
- **P**erianal disease
- **O**ld age
- **P**araphimosis
- **O**besity
- **P**VD
- **T**rauma
- **I**mmunosuppression (eg HIV)

Presentation

- significant genital edema and erythema - skin ischemia (necrotic areas)
- subcutaneous air on U/S or CT - pt usually unstable

management

- **clinical suspicion & recognition is the key**

- systemic Abx, IVFs
- multiple debridements
- wet-to-dry dressings for skin loss
- S/P urinary drainage for extensive infections to simplify wound care and prevent urethral complications from prolonged catheterization
- may consider hyperbaric O2
- thigh pouch or wet dressings for testes
- plastics consult for coverage

options for penile skin loss

1) small defects

- • wet gauze dressing
- • use of excess foreskin (if unCx'd) may allow 1° closure of mid to distal skin loss
- • scrotal rotation flaps for more proximal defects } poor cosmesis due to hair
- • local flaps (abdomen, thigh) } cosmetically inferior to STSGs

2) larger defects

- **thick, UNMESHED, STSGs preferred for extensive penile reconstruction**
- meshed grafts have better take but tend to contract and are less cosmetic
- remove all subcoronal skin remaining after debridement (prevent lymphedema)
- skin grafts on penile shaft NEVER regain normal sensation

options for genital burns

- ability to reconstruct damage depends on how well N structures have been maintained after the acute injury

- **careful debridement is the rule in acute management (less aggressive due to unique vascularity of genital tissue)**

- urethral injuries often devastating } may need PU

- penis often incarcerated in contracted scar tissue } gracilis musculocutaneous flap to release shaft then STSG to cover it

- reconstruction often requires a number of stages

- early resection of burn eschar

- **early coverage with STSG when possible } silver sulfadiazine cream if only minor**

options for scrotal skin loss

- **scrotal skin defects ≤50% can be closed primarily**
- for extensive defects, testes placed in thigh pouches or wet dressings until reconstruction
- **local skin flaps used to cover as much of defect as possible } medial thigh, rectus, etc**
- **MESHED STSGs used to cover rest of defect } improved take**
- neoscrotum may appear tight at first but does expand

management of the STSG donor site

- control bleeding by epinephrine-soaked Telfa dressing
- 1% siver sulfadiazine cream, Jelonet, 3% bismuth gauze
- place large semi-occlusive dressing
    - don't use vapour-occlusive dressings } high rate of infections
    - remove dressings when lifts off spontaneously or if infection occurs